A CENTENNIAL CATALOGUE OF HYDRO-GEOMORPHOLOGICAL COMPOUND EVENTS AND CORRESPONDING ATMOSPHERIC FORCING

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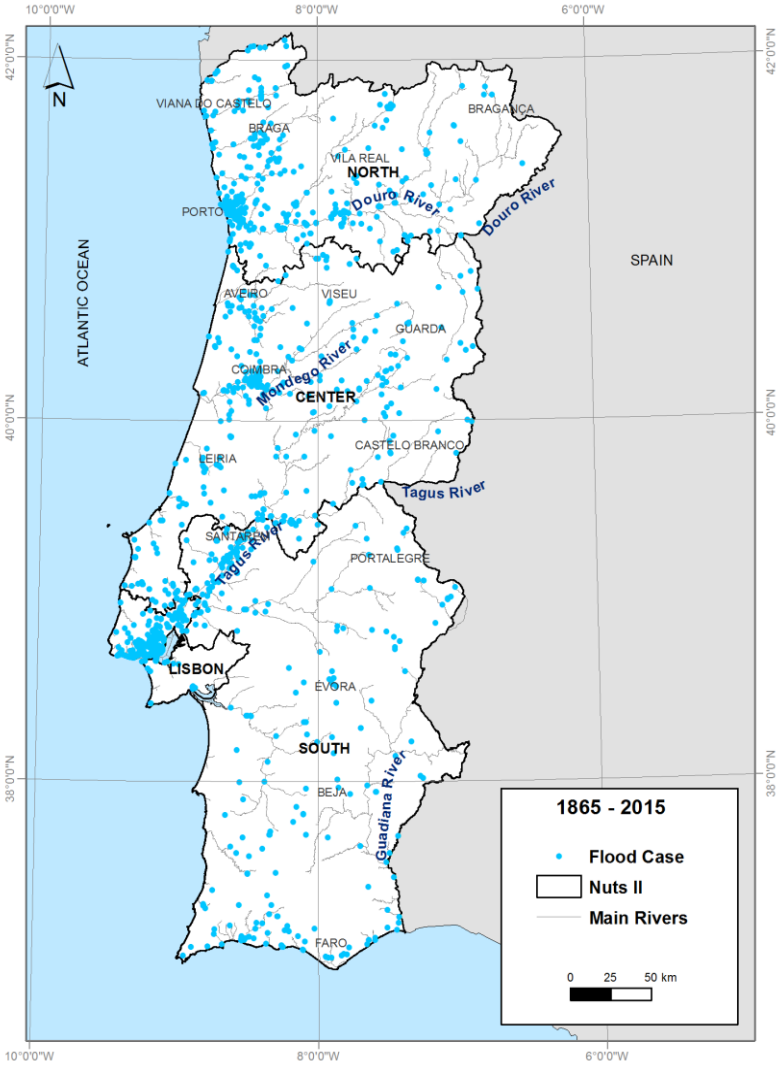
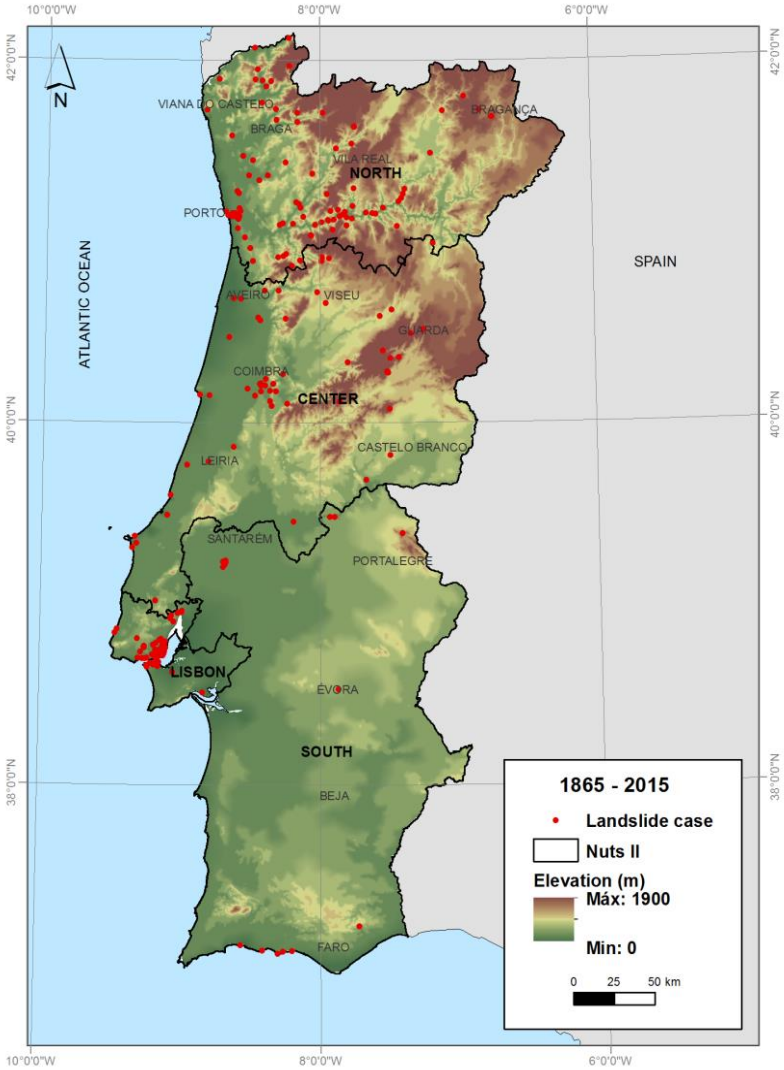
Outline

- Hydro-geomorphological events
- Atmospheric Drivers
  - Large Scale circulation (Weather Types)
  - Atmospheric Rivers
- The February 1979 event
- Hydro-geomorphological events vs Atmospheric Drivers
- Final Remarks

Hydro-geomorphological occurrences

The Hydro-Geomorphologic occurrences (***floods and landslides***) that take place in Portugal from ***1865 to 2015***, obtained from ***newspapers*** fulfilling the following criteria: any flood or landslide that, caused either **casualties**, **injuries**, **missing**, **evacuated** or **homeless** people.





Hydro-geomorphological events

How to join the occurrences in terms of **events:**

a) Include at least 3 occurrences;

b) Include occurrences with 3 or less interval days;

c) They must have spatial coherence.

130 Events

	Total
Fatalities	938
Evacuated	12087
Displaced	40827
Affected	54528

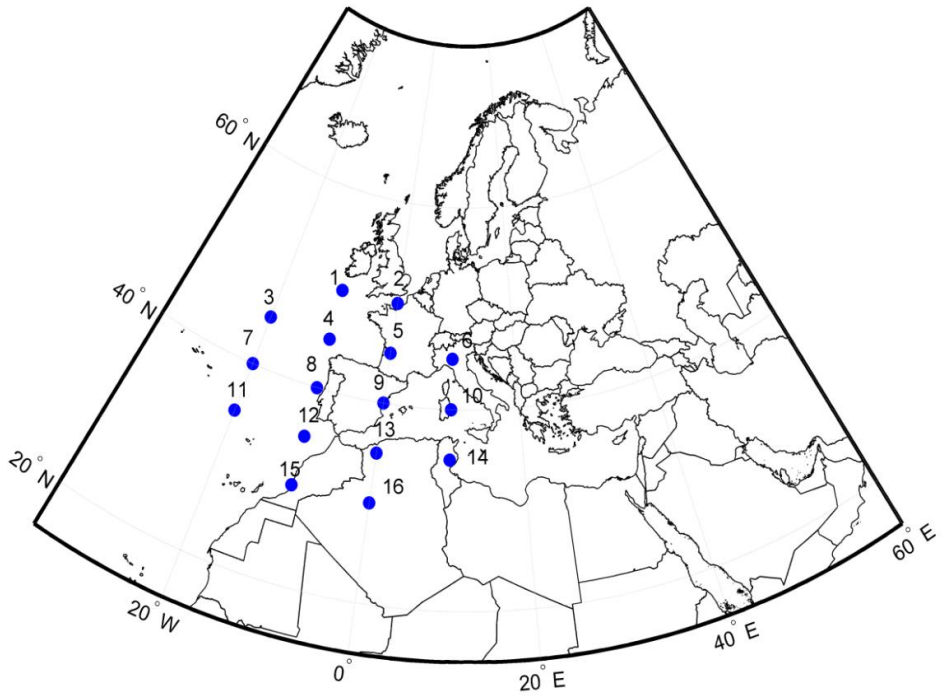
Hydro-geomorphological events

Type of **events**

Disaster event types and corresponding human impacts.

Disaster event type	% of events	% of fatalities	% of injured	% of evacuated people	% of displaced people
Floods	13.1	4.3	1.6	3.0	1.0
Flash floods	7.7	1.1	0.0	1.9	0.8
Urban floods	6.2	0.2	0.2	5.9	1.1
Landslides	0.8	0.0	1.2	0.0	0.0
Floods + flash floods	5.4	6.4	1.2	4.2	0.2
Floods + urban floods	5.4	0.4	2.3	2.5	12.7
Floods + landslides	19.2	7.5	9.8	8.2	5.3
Flash floods + urban floods	9.2	59.3	62.0	5.1	2.6
Urban floods + landslides	4.6	1.6	3.3	0.5	0.2
Floods + flash floods + urban floods	1.5	1.5	0.7	0.7	2.1
Floods + flash floods + landslides	3.8	2.3	3.5	37.0	36.4
Floods + urban floods + landslides	9.2	4.5	2.8	4.3	4.7
Flash floods + urban floods + landslides	8.5	3.0	3.8	14.7	26.9
Floods + flash floods + urban floods + landslides	5.4	8.0	7.7	12.0	6.2
66 events from 130	**50.7%**	**26.9%**	**30.9%**	**76.7%**	**79.7%**

Circulation Weather Types



SLP from 20C Reanalysis ***1865 to 2015***

Method (objective LAMB CWT)

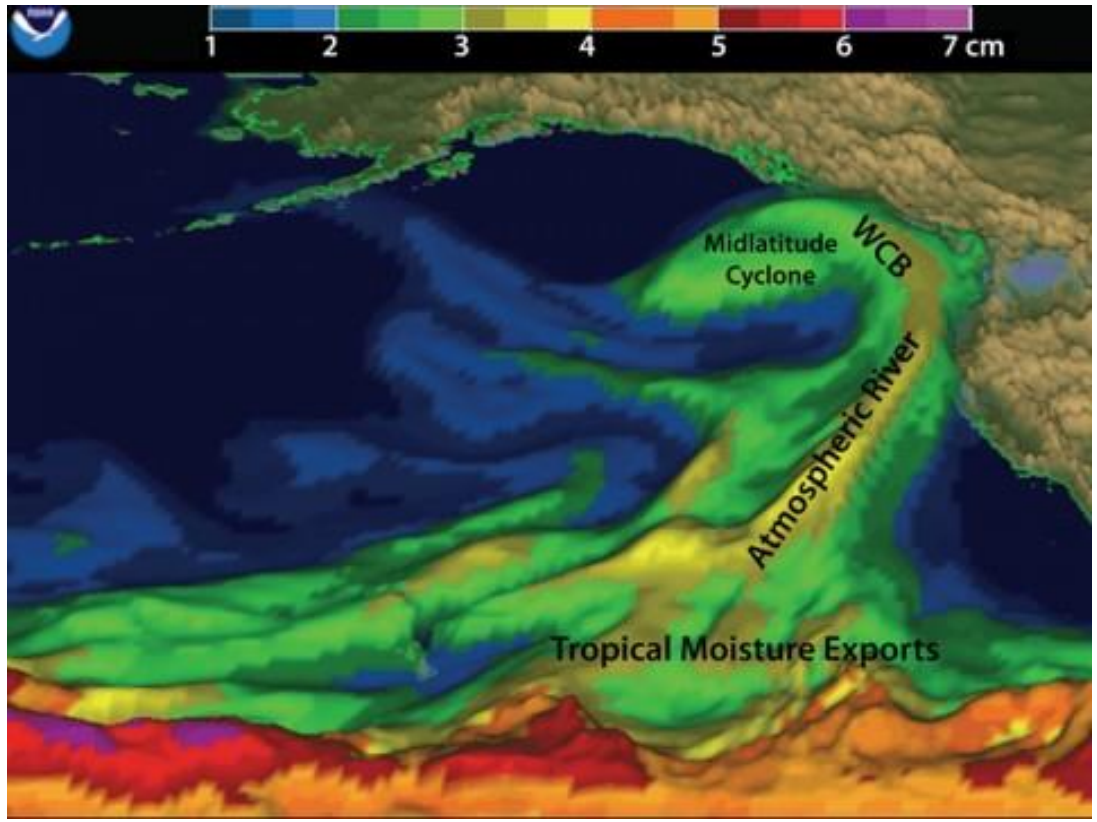
- The circulation conditions are determined using physical or geometrical parameters **based on 16 SLP grid points. (5° latitude by 10° longitude).**
- The conditions established to define different types of circulation are the same as in Trigo and DaCamara (2000).
- These rules allow 26 different weather types, 10 pure types (NE, E, SE, S, SW, W, NW, N, C, and A) and 16 hybrid types (8 for each C or A hybrid).

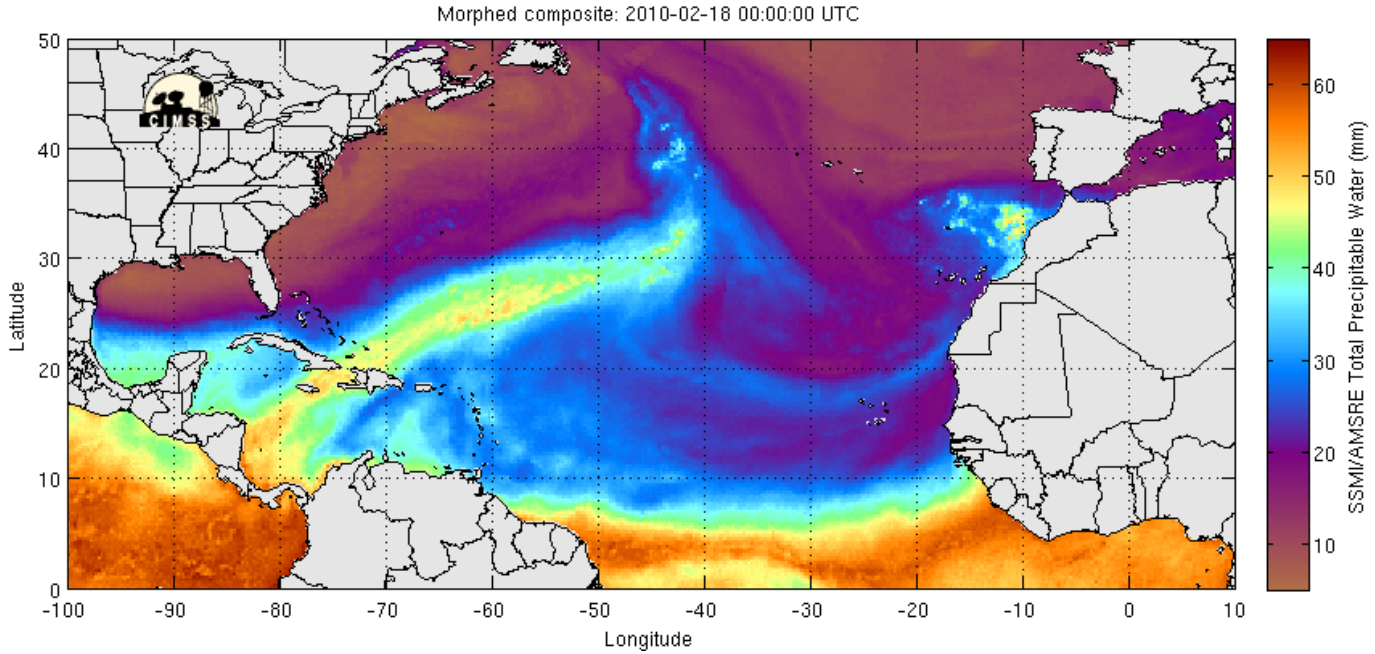
TABLE 1. (Above) Combined percentage of accumulated precipitation for the grouped WTs in the fall [September–November (SON)], winter (DJF), and spring [March–May (MAM)] seasons during the 1958–97 period. (Below) Relative frequency of each group (%).

Percentage accumulated precipitation
Relative frequency

	C	SW–W–NW	A	N–NE	S–SE–E
Winter	22.2	59.5	6.6	3.0	8.7
	7.8	28.1	40.2	8.6	15.3
Fall	28.8	51.5	5.6	2.9	11.2
	8.4	24.5	36.9	16.5	13.8
Spring	31.8	48.0	4.8	8.4	7.0
	10.9	23.5	32.7	21.4	11.6

Atmospheric Rivers

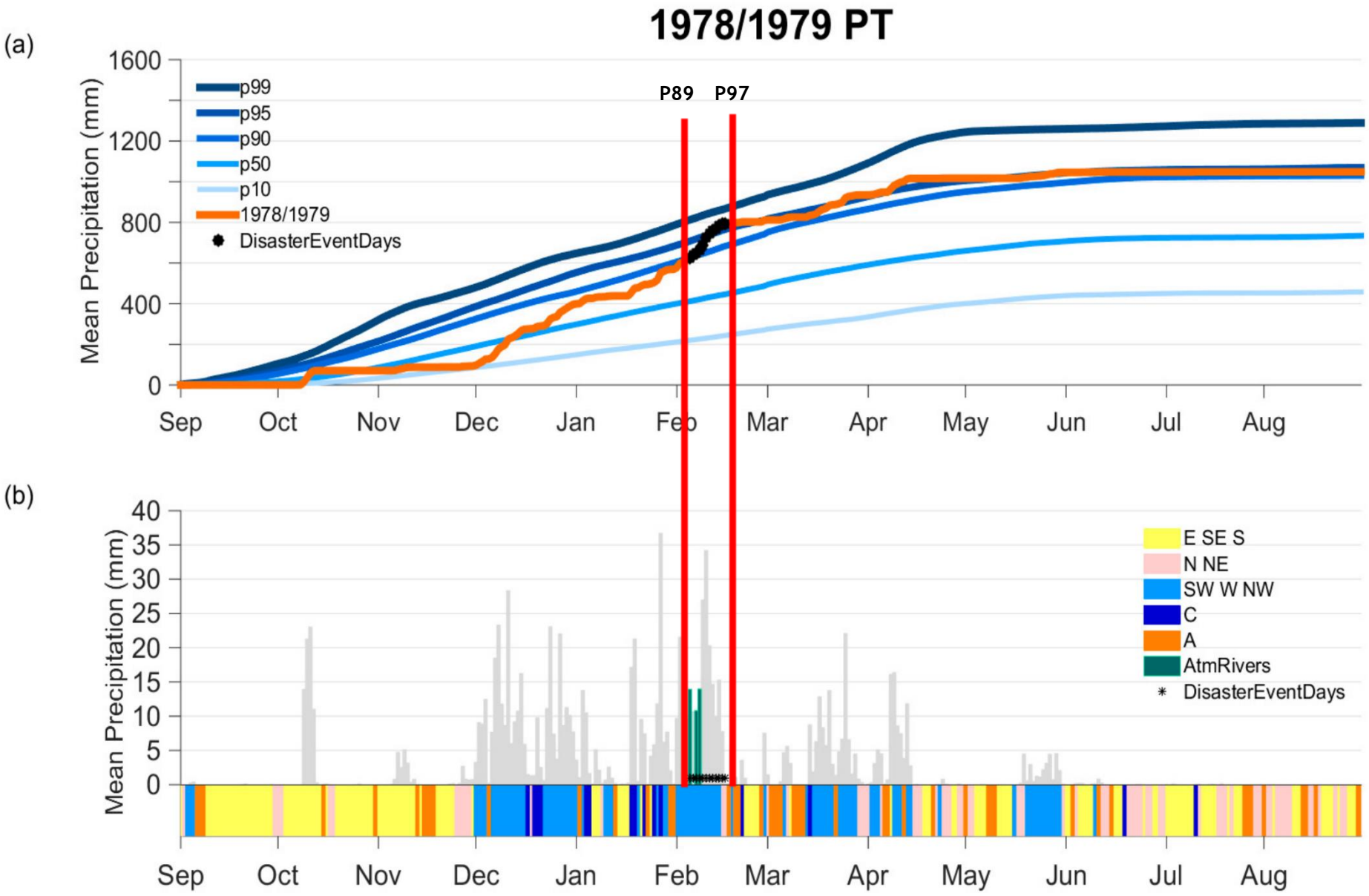




A long (~2000km), narrow (~850km), and transient corridor of strong horizontal water vapor transport that is typically associated with a low-level jet stream ahead of the cold front of an extratropical cyclone. The water vapor in atmospheric rivers is supplied by tropical and/or extratropical moisture sources. Atmospheric rivers frequently lead to heavy precipitation where they are forced upward—for example, by mountains or by ascent in the warm conveyor belt.

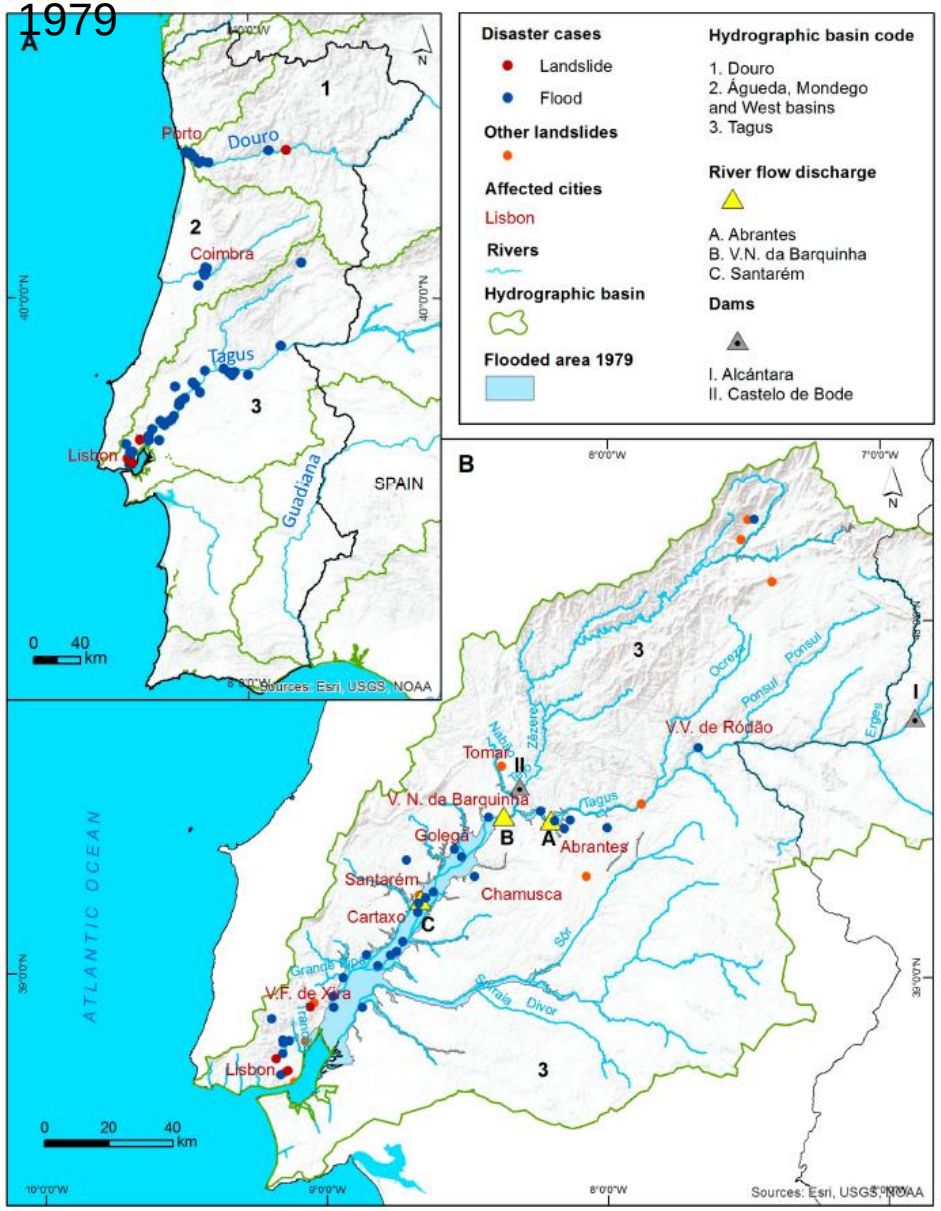
AMS, Glossary

The February 1979 event

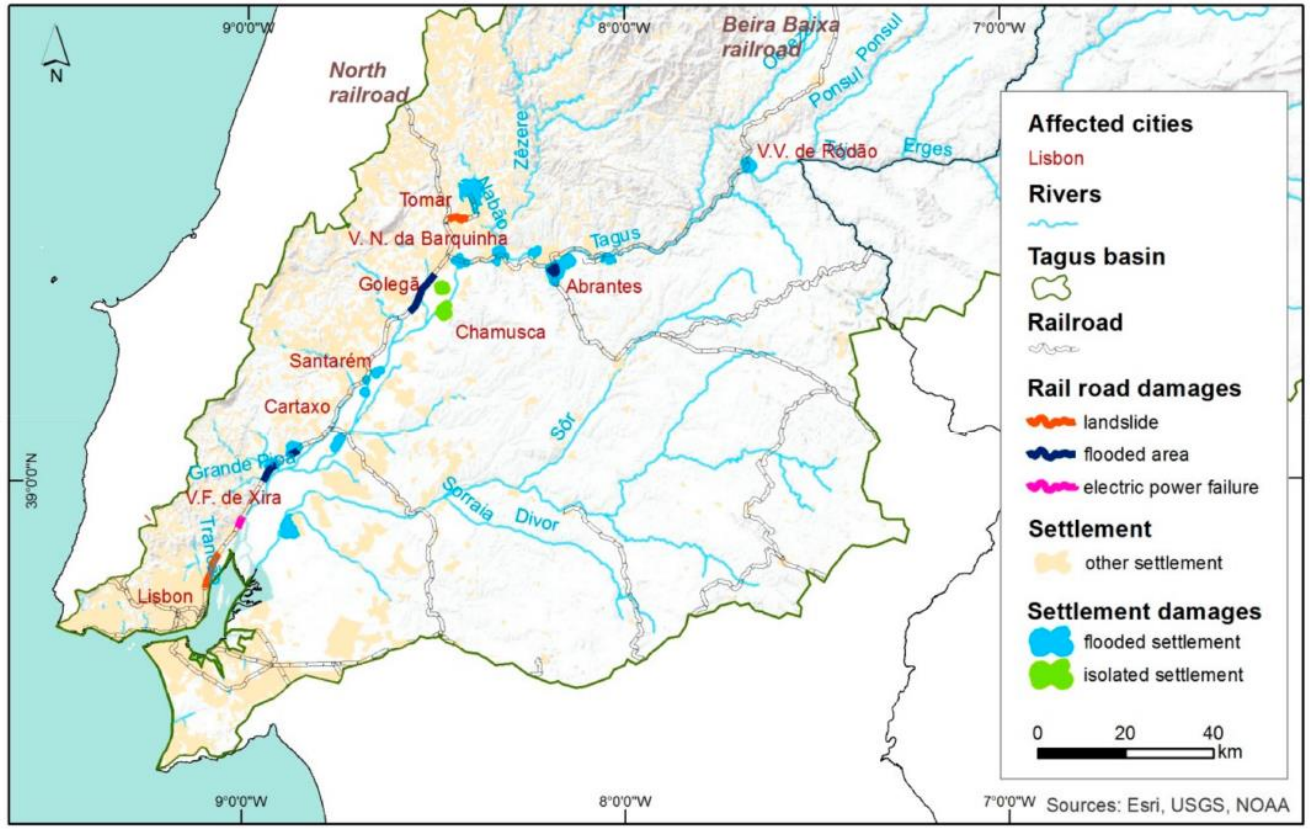


The February 1979 event

Flood and landslide from the 5–16 February 1979



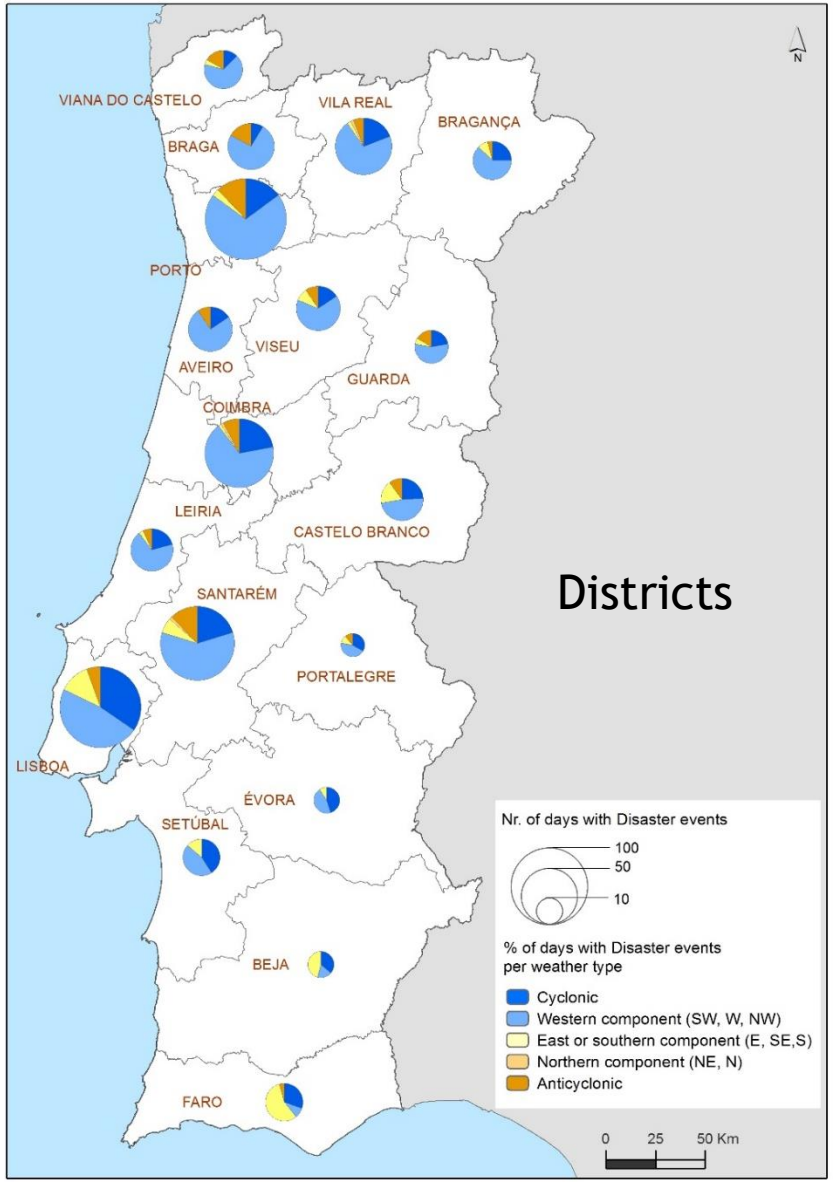
Settlement and railroad damages



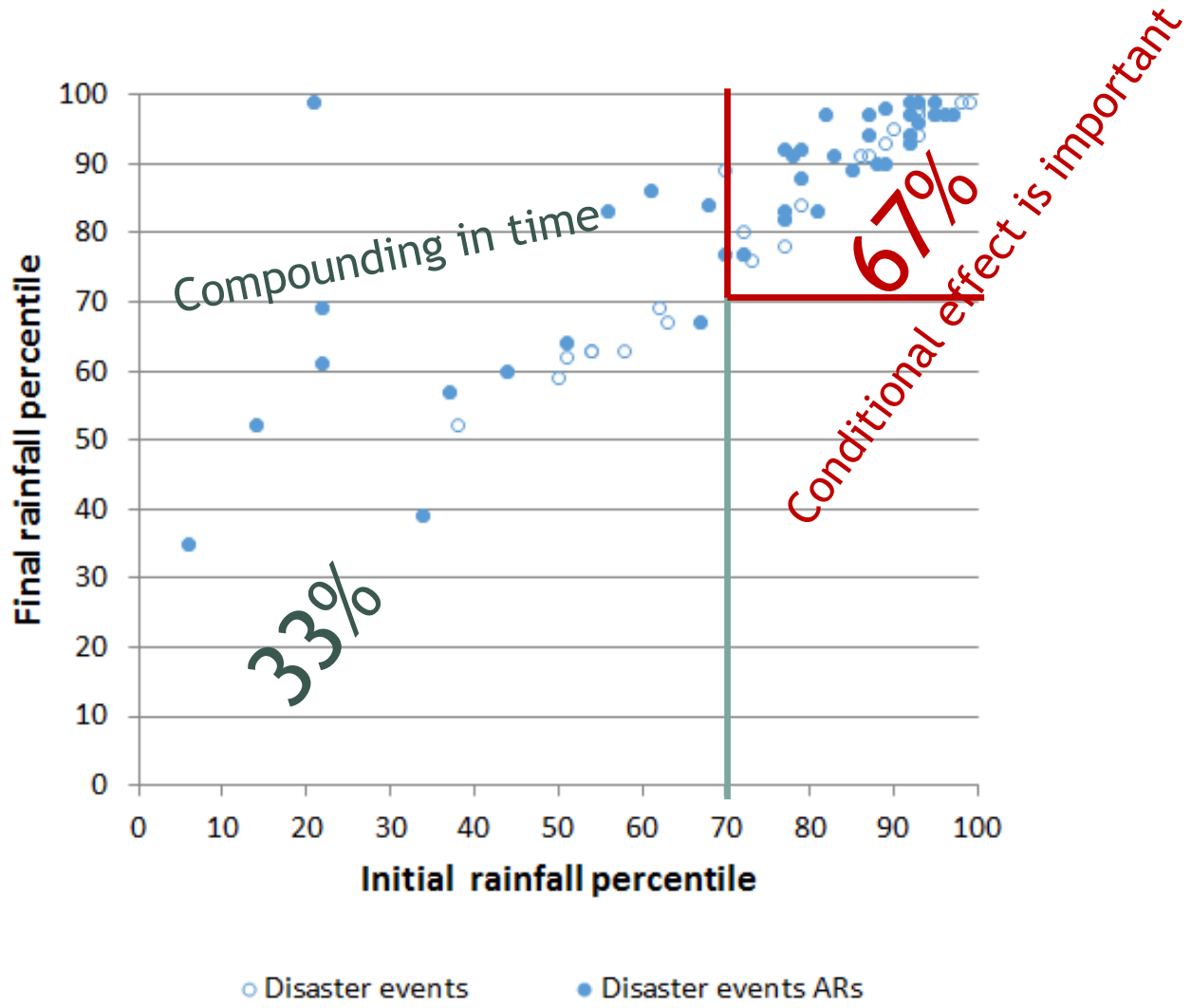
Hydro-geomorphological events atmospheric forcing

Frequency of WTs during the events(%)
66 events with duration of 290 days

E / SE / S	NE / N	SW / W / NW	C	A
8,2	0,4	59,9	22,5	9,0



Hydro-geomorphological events atmospheric forcing



first day and **last day** accumulated rainfall percentile of the climatological year for each event and the presence of **ARs during the event**

Hydro-geomorphological events atmospheric forcing

ARs influence in the events

	Events	Days Events	Dead
Database	66	290	252
Database only with ARs	40	224	200
	~60%		~80%

Pereira et al., 2018, Adv. Water Res

Final Remarks

- Events selection taking into account: number of occurrences, temporal and spatial coherence;
- Half of the events have multiple impacts (floods and landslides);
- In terms of Atmospheric circulation, for the North and Central Portugal, the C and the Westerly types were responsible for more than 2/3 of the events, while for Southern Portugal the East and Southerly types emerge.
- Accumulated precipitation till the Hydro-Geomorphologic events can be important to trigger them - Conditional effect.
- ARs are present in circa 60% of the events which reveal it´s importance as an atmospheric forcing to increase the amount of precipitation - Compounding in time if clustering of ARs occur.

Acknowledgements

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